Neutron Backgrounds in Coherent Neutrino-Nucleus Scattering Experiments

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ABSTRACT

Coherent neutral-current neutrino scattering (coherent-NCνAs), though predicted by the Standard Model, has not been observed. The scattering process is mediated by the exchange of a Z^0 vector boson between the incident neutron and target nucleus. The cross-section thus scales with $(A-Z)^2$, similar to the A^2 scaling of candidates for particle dark matter. In addition, the process plays a role in stellar collapse and significant deviations from the Standard Model cross-section could be a signal of new physics. It has been proposed that off-axis neutrinos from Fermilab's Booster Neutrino Beam (BNB) could be used to search for coherent-NCνAs using a liquid argon detector. Neutron scattering may mimic the signal of coherent-NCνAs in the proposed detector, and thus neutron shielding is necessary to reduce backgrounds. In this project, we use Monte Carlo simulations to study the effectiveness of different thicknesses of concrete in blocking neutron radiation. We have determined an approximate attenuation length for neutrons in concrete. By comparing this with the expected number of coherent-NCνAs events in the detector and the estimated neutron flux at the proposed site, we determine an appropriate thickness of concrete to reduce the neutron background to appropriate levels.